

Claims

1. A method for reducing an influence of interference in a multi-user receiver, when the multi-user receiver receives signals from users having different data rates using at least two antenna elements, the method comprising:

creating a spatial covariance matrix estimate from wideband antenna signals by sampling, arranging sampled values into a signal vector and by multiplying the signal vector by a conjugate transpose vector of the signal vector,

determining a whitening filter based on a spatial covariance matrix estimate;

whitening received signals by using the whitening filter;

removing whitening from signals of predetermined users by using an inverse matrix of a matrix used in the whitening filter; and

conveying whitened signals and signals from which the whitening has been removed to a receiver element, which carries out multi-path combining and multi-antenna combining.

2. The method of claim 1, wherein the said whitening is carried out by matrix vector multiplication.

3. The method of claim 1, further comprising:

using maximum ratio combining by the receiver element for performing multi-path combining and multi-antenna combining according to a Rake principle.

4. The method of claim 1, wherein said determining comprises determining the whitening filter by using a Cholesky decomposition.

5. The method of claim 1, wherein the said removing comprises removing the whitening from the predetermined users which are determined based on a bit rate threshold.

6. A multi-user receiver which uses at least two antenna elements and in which an influence of interference is reduced, the multi-user receiver comprising:

pre-filtering means for pre-filtering a wideband antenna signal, the pre-filtering means being determined based on a spatial covariance matrix estimate, the spatial covariance matrix estimate is obtained from wideband antenna signals by sampling, arranging sampled values into a signal vector and by multiplying the signal vector by a conjugate transpose vector of the signal vector;

removing means for removing whitening from signals of predetermined users by using an inverse matrix of matrix used in a whitening filter; and

performing means for performing multi-path combining and multi-antenna combining.

7. A multi-user receiver which uses at least two antenna elements and in which an influence of interference is reduced, the multi-user receiver comprising:

a branch with a whitening arrangement, another branch without a whitening arrangement and a switching arrangement conveying received signals to the branch with the whitening arrangement or to the another branch without the whitening arrangement depending on a used bit rate; and

a receiver element performing multi-path combining and multi-antenna combining.

8. A multi-user receiver in which an influence of interference is reduced, the multi-user receiver comprising:

a pre-filter whitening a wideband antenna signal, the pre-filter being determined based on a spatial covariance matrix estimate, the spatial covariance matrix estimate is obtained from wideband antenna signals by sampling, arranging sampled values into a signal vector and by multiplying the signal vector by a conjugate transpose vector of the signal vector;

a whitening removing arrangement removing the whitening from signals of predetermined users by using an inverse matrix of a matrix used in a whitening filter; and

a receiver element performing multi-path combining and multi-antenna combining.

9. The multi-user receiver of claim 6, wherein the whitening is carried out by complex matrix multiplication.

10. The multi-user receiver of claim 7, wherein the whitening is carried out in the whitening arrangement by complex matrix multiplication.

11. The multi-user receiver of claim 7, wherein the receiver element performing the multi-path combining and the multi-antenna combining comprises a maximum ratio combiner.

12. The multi-user receiver of claim 8, wherein the receiver element performing the multi-path combining and the multi-antenna combining comprises a maximum ratio combiner.

13. The multi-user receiver of claim 6, wherein the performing means for performing the multi-path combining and the multi-antenna combining comprises a maximum ratio combiner.

14. The multi-user receiver of claim 6, wherein the multi-user receiver further comprises determining means for determining the predetermined users from whom whitening is removed based on a bit rate threshold.

15. The multi-user receiver of claim 7, wherein the multi-user receiver further comprises determining means for determining the predetermined users from whom the whitening is removed based on a bit rate threshold.

16. The multi-user receiver of claim 8, wherein the multi-user receiver further comprises determining means for determining the predetermined users from whom the whitening is removed based on a bit rate threshold.

17. A base station comprising a multi-user receiver, the multi-user receiver uses at least two antenna elements and, in the base station, an influence of an interference is reduced, the base station comprising:

pre-filtering means for pre-filtering a wideband antenna signal, the pre-filtering means being determined based on a spatial covariance matrix estimate, the spatial covariance matrix estimate is obtained from wideband antenna signals by sampling, arranging sampled values into a signal vector and by multiplying the signal vector by a conjugate transpose vector of the signal vector;

removing means for removing whitening from signals of predetermined users by using an inverse matrix of a matrix used in a whitening filter; and

performing means for performing multi-path combining and multi-antenna combining.

18. A base station comprising a multi-user receiver, the multi-user receiver uses at least two antenna elements and, in the base station, an influence of an interference is reduced, the base station comprising:

a branch with a whitening arrangement, another branch without a whitening arrangement and a switching arrangement conveying received signals to the branch with the whitening arrangement or to the another branch without the whitening arrangement depending on a used bit rate; and

an element performing multi-path combining and multi-antenna combining.

19. A base station comprising a multi-user receiver, the multi-user receiver uses at least two antenna elements and, in the base station, an influence of an interference is reduced, the base station comprising:

- a pre-filter whitening a wideband antenna signal, the pre-filter being determined based on a spatial covariance matrix estimate, the spatial covariance matrix estimate is obtained from wideband antenna signals by sampling, arranging sampled values into a signal vector and by multiplying the signal vector by a conjugate transpose vector of the signal vector;

- a whitening removing arrangement removing whitening from signals of predetermined users by using an inverse matrix of a matrix used in a whitening filter' and

- an element performing multi-path combining and multi-antenna combining.